(54) Title: PAGER AND RADIOTELEPHONE APPARATUS
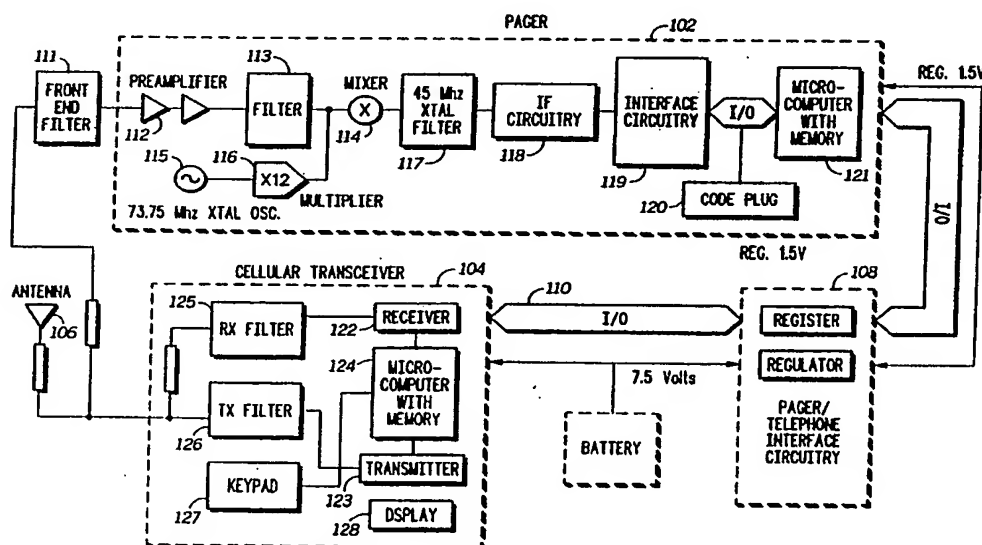
(57) Abstract

The present invention encompasses a pager and radiotelephone apparatus (100) having a radio pager section (102) and a cellular radiotelephone section (104) into one unit. The apparatus (100) may automatically receive a plurality of pages while the cellular radiotelephone section (104) is on, communicating a cellular telephone call, or off and unattended. The received pages are stored in the pager section (102) until the apparatus user acknowledges their receipt by a keystroke. The pages are then transferred to the radiotelephone section (104) and stored in non-volatile memory for later use.

PAGER AND RADIOTELEPHONE APPARATUS

Field of the Invention

5   The present invention relates to both the paging
industry and the cellular radiotelephone industry.

Background of the Invention

10   Paging systems are typically one way radio
communication systems. An individual wishing to
communicate with a pager user usually calls a central
telephone number to access the central paging control. The
central paging control can be either automatic or operated by a
15   human operator. If automatic, the caller keys in the number
assigned to the individual pager they wish to reach. Once that
pager is accessed, the caller can either leave a voice message
for the paged individual or key in the telephone number to be
displayed on the pager's display. Some systems may also
20   allow both types of paging.

         If the central paging control is operated by a human op-
erator, the caller typically tells the operator the number of the
pager and the message. The operator then pages the individ-
ual, and relays the message when the paged individual calls
25   the operator.

         Once paged, the individual must find a telephone to an-
swer the page. This problem can be solved by the paged indi-
vidual carrying a cellular radiotelephone. The radiotelephone
allows a mobile user to make or receive a call anywhere
30   within an area covered by the cellular communications sys-
tem antennas.

         One problem with radiotelephone communication is
that the radiotelephone user typically pays for incoming as
well as outgoing calls. If an unwanted call is made to the ra-
35   diotelephone, therefore, the radiotelephone user must pay for

it at much higher rates than receiving a page. The pager, therefore, allows the called party to screen incoming calls to determine which telephone number to call back, thereby eliminating the charges for unwanted calls.

5   While the pager solves some of the limitations of the cellular radiotelephone and vice versa, this creates the problem of carrying two communication devices to remain in contact while moving about an area. There is a need therefore for a single device combining the advantages of both the cellular

10   radiotelephone and the pager.

Summary of the Invention

The present invention encompasses a pager and

15   radiotelephone apparatus combining a radio pager and a cellular radiotelephone into one unit, which may automatically receive a plurality of pages while the cellular radiotelephone is on, communicating a cellular telephone call, or off and unattended.

20

Brief Description of the Drawings

Fig. 1 shows a block diagram of a pager and radiotelephone apparatus 100 embodying the present

25   invention.

Fig. 2 shows a flow chart for the process executed by the microcomputer of the cellular transceiver 104 in Fig. 1.

Fig. 3 shows a schematic of the interface circuitry 108 of the pager and radiotelephone apparatus in Fig. 1.

30

Description of a Preferred Embodiment

The radiotelephone and pager apparatus (100), illustrated in Fig. 1 and embodying the present invention,

combines a radio pager section (102) and a cellular
radiotelephone section (104) into one small, lightweight unit.
An example of a radio pager (102) is the pager shown and
described in Motorola instruction manual number
5   68P81006B85-0, entitled "BRAVO SERIES Numeric Display
Pagers A05JRB/C Models 929-932 MHz", and the pager shown
and described in Motorola instruction manual number
68P81044C10-A, entitled "SENSAR SERIES GSC Display Radio
Pagers A05JRB/C Models 450-470 MHz". An example of a
10 radiotelephone (104) is the portable radiotelephone shown and
described in Motorola instruction manual number
68P81054E60-0, entitled "DYNATAC Cellular Portable
Telephone". All of these instruction manuals are published by
and available from Motorola C & E Parts, 1313 East Algonquin
15 Road, Schaumburg, Illinois 60196.

A single antenna (106) is shared by both the pager
section (102) and radiotelephone section (104). The antenna
(106) is coupled via microstrip transmission lines to receive
(125) and transmit (126) filters in the radiotelephone section
20 (104) and a front-end receive filter (111) in the radio pager
section (102).

A received signal, with a 930 MHz frequency in the
preferred embodiment, from the front-end filter (111) is
amplified by the preamplifier (112) and filtered by the filter
25 (113) in the pager section (102). A 73.75 MHZ crystal oscillator
(115) signal is multiplied by twelve in multiplier (116)
resulting in an 885 MHz injection signal that is mixed in
mixer (114) with the 930 MHZ signal from the front-end filter
(111), resulting in a 45 MHz signal. A 45 MHz crystal filter
30 (117) attenuates the signal above and below the 45 MHz RF
carrier and the resulting signal is demodulated into a 455 kHz
signal by the intermediate frequency circuit (118). This signal
is then input to an interface circuit (119) in the pager section
(102).

The interface circuit (119) of the pager section (102)
interfaces the input signal to the microcomputer (121) in
addition to squaring up the signal and providing power
regulation for the rest of the pager section(102). The
5 microcomputer (121) contains a stack for storage of the
incoming pages. In the preferred embodiment, the
microcomputer (121) is capable of storing ten telephone
numbers, although any number of telephone numbers maybe
stored by changing the size of the stack. The microcomputer
10 (121) also controls the pager section (102). Non-volatile
memory, also known in the art as a code plug (120), has the
identification number assigned to that particular pager
section (102) in addition to the options available for the pager.
Paging signals or pages transmitted to the pager section (102)
15 include the identification number and a telephone number.
Each time the pager section (102) is turned on, the
microcomputer (121) reads the data stored in the code plug
(120) and uses the read-out identification number to select its
pages received on the 930 MHz paging channel.
20   The pager/telephone interface circuitry (108), illustrated
in Fig. 3, interfaces the pager section (102) to the
radiotelephone section (104). This circuity contains a 128-bit
shift register (302), a Motorola-type MC14517B integrated
circuit, to store pages from the pager, and a dual D-type flip
25 flop, a Motorola-type MC14013BD integrated circuit, to control
the power state of the pager section (102). This flip flop is also
used by the pager section (102) to give a page received
indication to the radiotelephone section (104). In addition, the
power-on LED (303) for the pager section (102) is also contained
30 in this interface (108).
        The radiotelephone section (104) is comprised of a
receiver (122) and transmitter (123) controlled by a
microcomputer (124), a Motorola-type 68HC11 microcomputer
in the preferred embodiment. The microcomputer (124) is also

coupled to the display (128) for displaying telephone numbers and status messages, and to the keypad (127) having numeric pushbuttons for dialing phone numbers and function pushbuttons, such recall, clear and send pushbuttons, for

5 controlling operation of radiotelephone section (104). An I/O bus (110) couples the radiotelephone's microcomputer (124) to the pager/telephone interface circuitry (108). The receive filter of the radiotelephone section (104) is coupled to the radiotelephone receiver (122). A radiotelephone call signal

10 that is received by the receiver (122) is routed to the microcomputer (124) for processing. A radiotelephone call to be made by the radiotelephone section (104) is routed by the microcomputer (124) to the transmitter (123) that is coupled to the transmit filter.

15 The process performed by the microcomputer (124) in the radiotelephone section (104) of the pager and radiotelephone apparatus (100) is illustrated in Fig. 2. When the apparatus (100) receives a page (201), it is stored in the stack of the pager section's microcomputer (121). This page

20 data is in a format that includes characters, such as hyphens, besides the telephone number to be called. After the page data is stored, the PAGE RCVD INDICATION line toggles rapidly which causes the output of the comparator to go low, thereby clocking in a high into the D flip flop (301). The output of the D

25 flip flop (301) sets the page received line (PG RCVD) high and the ON/OFF line low. If the radiotelephone section (104) is off (202) when the page is received, the ON/OFF line going low powers it up (203) in order to inform the user that a page has been received and to give the user a chance to respond to the

30 page. Additionally, a power-on flag is set so that later the radiotelephone section knows that it was powered up by the pager. If the radiotelephone section (104) is already on when the ON/OFF line goes low, this signal is ignored (204) by the 68HC11 microcomputer (124). A page counter in the 68HC11

microcomputer (124) is also incremented (205) enabling the apparatus to keep track of when the stack in the pager section's microcomputer is full.

5   After the radiotelephone section (104) is on, the appropriate message is displayed in the apparatus' display (128) announcing the page receipt. In addition, an annunciation tone is turned on to aurally inform the user of the page. This tone, in the preferred embodiment, is turned on for ten short bursts. If a page is received and the pager
10   section's microcomputer stack is not full, the message "PAGE" is displayed. If the last page received filled up the stack, the message "PAGFULL" is displayed. Other messages may also be used. For example, if two pages have been received and the pager section's microcomputer stack is not
15   full, the message " 2 PAGES" may be displayed. An annunciation tone, different from the normal page received tone, is used to aurally inform the user that the memory is full. If the last page received overflows the stack, making the number of pages received greater than five, the message
20   "OVERFLO" is displayed. This last message will be displayed for each successive page received that overflows the stack.

     Once the user knows a page is present, some action by the user (206) is necessary to move the page from the pager section (102) to the radiotelephone memory for display or
25   dialing. If no action is taken by the user within a certain time period (208), six seconds in the preferred embodiment, the power-on flag is checked (212) to determine if the pager turned on the radiotelephone section (104). If the flag is set, the radiotelephone section (104) is powered down (211) to conserve
30   battery power, while the pager section remains on. The flag not set indicates that the user turned on the radiotelephone section (104) and wishes it to remain on.

     The user has three options to respond to a page using the keypad (127): a recall pushbutton (RCL) recalls the page

into the display of the apparatus, a clear (CLR) pushbutton clears the page from the apparatus display and the radiotelephone section's scratchpad memory, and a send (SND) pushbutton calls the page telephone number stored in

5   scratchpad memory. If the radiotelephone section (104) is powered down without response by the user, as long as the pager section (102) remains powered up, the page data will be stored in the microcomputer (121) stack for later use. When the radiotelephone section (104) is powered up again, "PAGE"

10   will be displayed to inform the user that a page is waiting. Powering down the radiotelephone section (104) with the pager section (102) still powered up will cause a unique tone to be emitted to indicate that the pager section (102) is still on and, therefore, using power.

15   When the SND, CLR, or RCL pushbuttons are activated (209), all the pages (ie. telephone numbers) in the pager section's microcomputer stack (121) is moved, one page at a time, from the stack to the shift register (302) in the pager/telephone interface circuitry (108). Initially, a memory

20   pointer in the microcomputer (121) is set to point to the first page in the stack. This page data is moved to the shift register(302) by clocking the page data, on the PGR DATA line, with the bidirectional PGR CLK line. Once the page data is in the shift register (302), the radiotelephone section (104)

25   can use the same clock line (PHN CLK) to clock the page data from the shift register (302) on the data line (PHN DATA) to the non-volatile memory of the microcomputer (124). The PGR RESET line is then pulsed to move the memory pointer to the next page or the next part of the first page and the memory

30   transfer operation is repeated (each page may have two parts). As the page data is clocked into the non-volatile memory of the radiotelephone section (104), it is decoded to get rid of all non-numeric characters. The page counter is decremented after

each page is clocked into the radiotelephone section's memory. This continues until the page counter is zero.

Once the telephone numbers of each page are stored in non-volatile memory of the radiotelephone section (104), the

5   pushbutton that was activated is processed (210) to determine what to do with the telephone numbers. No matter which pushbutton was entered, the most recent telephone number will be moved into the radiotelephone section's scratchpad memory while the remaining telephone numbers will remain

10 in the non-volatile memory. If the SND pushbutton was activated, the telephone number in scratchpad memory is called. If the CLR pushbutton was activated, the scratchpad memory will be cleared but the telephone numbers stored in the non-volatile memory will remain for later recall. If the

15 RCL pushbutton was activated, the scratchpad memory will be displayed but not called. Different location in the scratchpad memory can be recalled by actgivating the RCL pushbutton followed by a numeric pushbutton.

Once all the page data is moved out of the pager section

20 (102), the PAGER ON/OFF line is pulsed high momentarily by the 68HC11 microcomputer (124) to toggle the D flip flop (301), thereby turning the pager section (102) off. This clears the pages stored in the pager section's microcomputer (121). The PAGER ON/OFF line is pulsed again to turn the pager section

25 (102) back on.

One skilled in the art will know that various aspects of the present invention can be changed while still remaining within the scope of the invention. These changes may include the number of pages stored in the microcomputer stack, the

30 number of telephone numbers stored in the radiotelephone section, and the time the radiotelephone section remains on. In summary, a combination radiotelephone/pager apparatus has been shown that permits operation in both radiotelephone and paging systems.

Claims

1. A pager and radiotelephone apparatus for
communicating radiotelephone call signals on radiotelephone
5   channels and receiving paging signals on a paging radio
channel, the radiotelephone/pager apparatus comprising:
       pager means for receiving and storing a plurality of
radio paging signals each having a telephone number with at
least one digit, said pager means further providing an
10   indication signal when each paging signal has been received,
and said pager means responsive to a control signal for
reading out said stored telephone numbers; and
       cellular transceiver means being coupled to the pager
means and having at least a recall pushbutton and a send
15   pushbutton, said cellular transceiver means responsive to the
indication signal for counting the number of paging signals
received, responsive to activation of the recall or send
pushbutton for generating the control signal and receiving
and storing each read-out telephone number, and responsive
20   to activation of the send pushbutton for transmitting
radiotelephone call signals using the last received read-out
telephone number.

2. A pager and radiotelephone apparatus for communicating radiotelephone call signals on radiotelephone channels and receiving paging signals on a paging radio channel, the radiotelephone/pager apparatus comprising:

5   pager means for receiving and storing a plurality of radio paging signals each having a telephone number with at least one digit, said pager means further providing an indication signal when each paging signal has been received, and said pager means responsive to a control signal for

10   reading out said stored telephone numbers, said pager means further responsive to an on/off signal, and said pager means further responsive to a reset signal;

register means coupled to the pager means for receiving each read out telephone number; and

15   cellular transceiver means having at least one control pushbutton and being coupled to the pager means and the register means, said cellular transceiver means responsive to the indication signal for counting the number of paging signals received, said cellular transceiver means coupled to

20   the register means for generating the control signal enabling said pager means to read out the stored telephone numbers, for generating the on/off signal for controlling power to the pager means, for generating the reset signal for scrolling through the stored telephone numbers, and transmitting

25   radiotelephone call signals using the telephone number received in corresponding paging signal.

3. A method for controlling a combination pager and radiotelephone apparatus, said combination pager and radiotelephone apparatus including pager means for receiving on a paging radio channel a plurality of radio

5   paging signals each having a telephone number with at least one digit, and said combination pager and radiotelephone apparatus including cellular transceiver means being coupled to the pager means and having at least a recall and send pushbutton for transmitting on radiotelephone channels

10   radiotelephone call signals, the method comprising the steps of:

receiving and storing in said paging means a plurality of radio paging signals each having a telephone number with at least one digit;

15   producing an indication signal when each paging signal has been received in said paging means;

reading out in response to a control signal said stored telephone numbers in said paging means;

counting in response to said indication signal the

20   number of paging signals received in said cellular transceiver means;

generating in response to activation of the recall or send pushbutton the control signal and receiving and storing each read-out telephone number in said cellular transceiver

25   means; and

transmitting in response to activation of the send pushbutton radiotelephone call signals using the last received read-out telephone number in said cellular transceiver means.
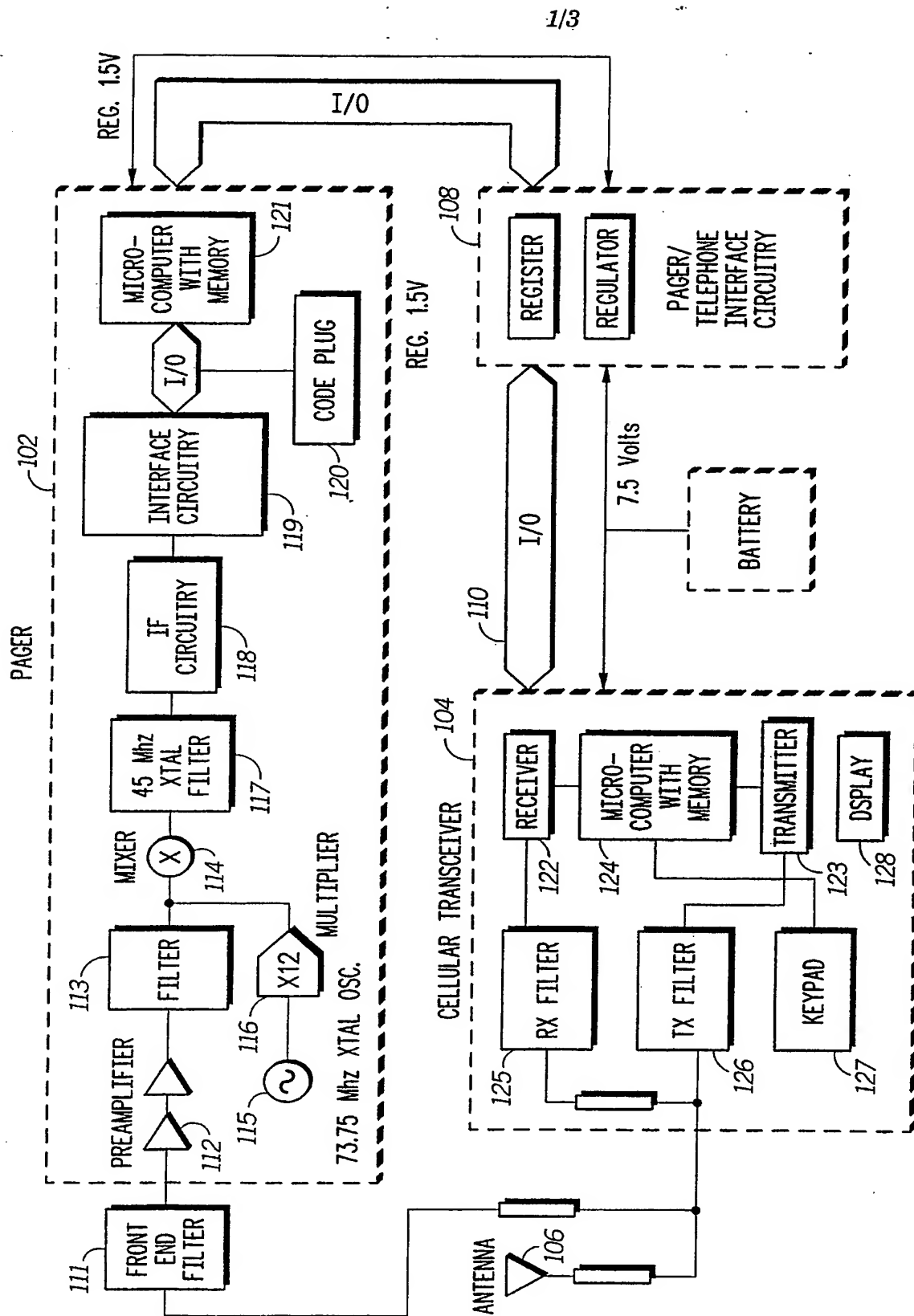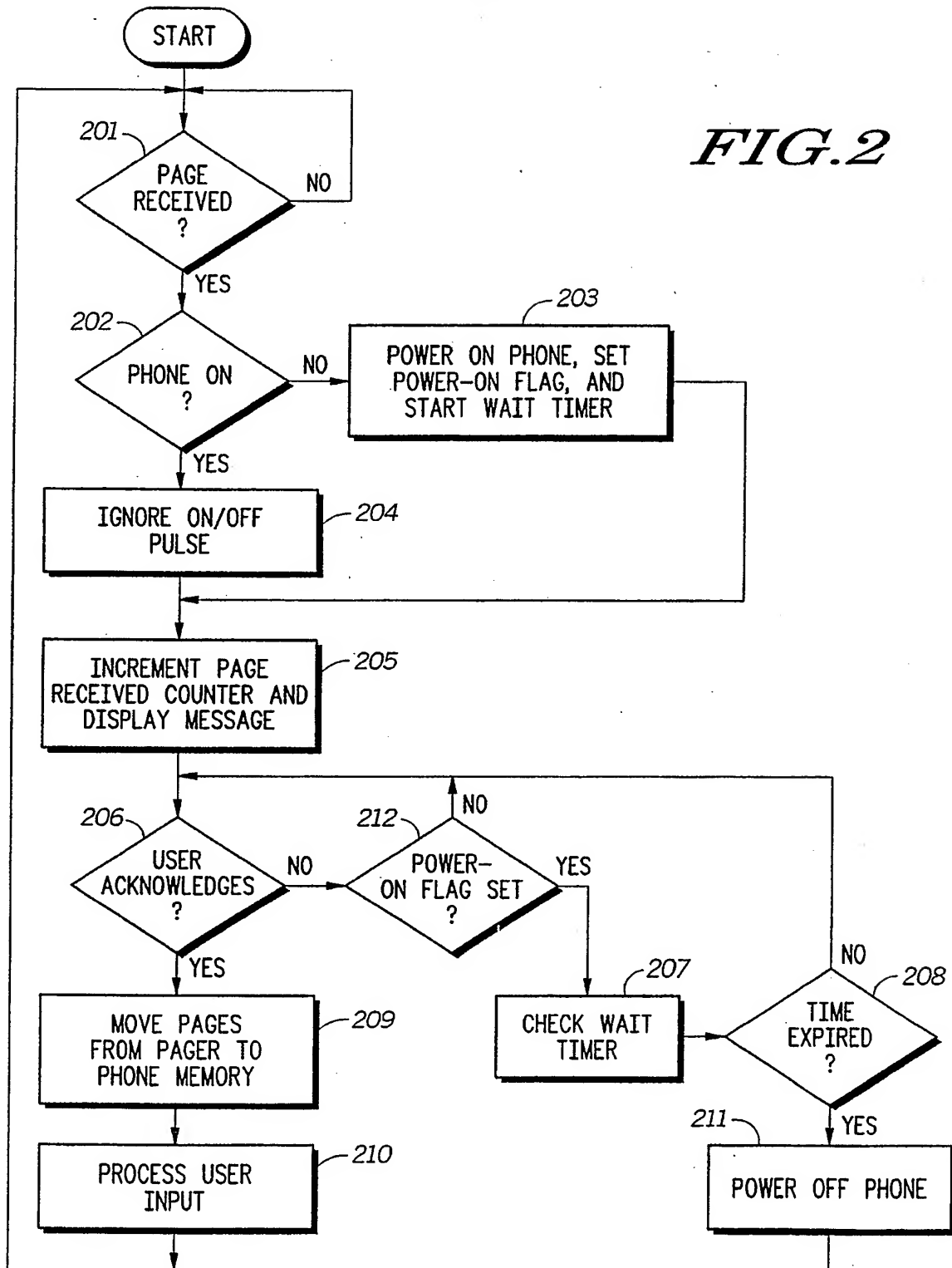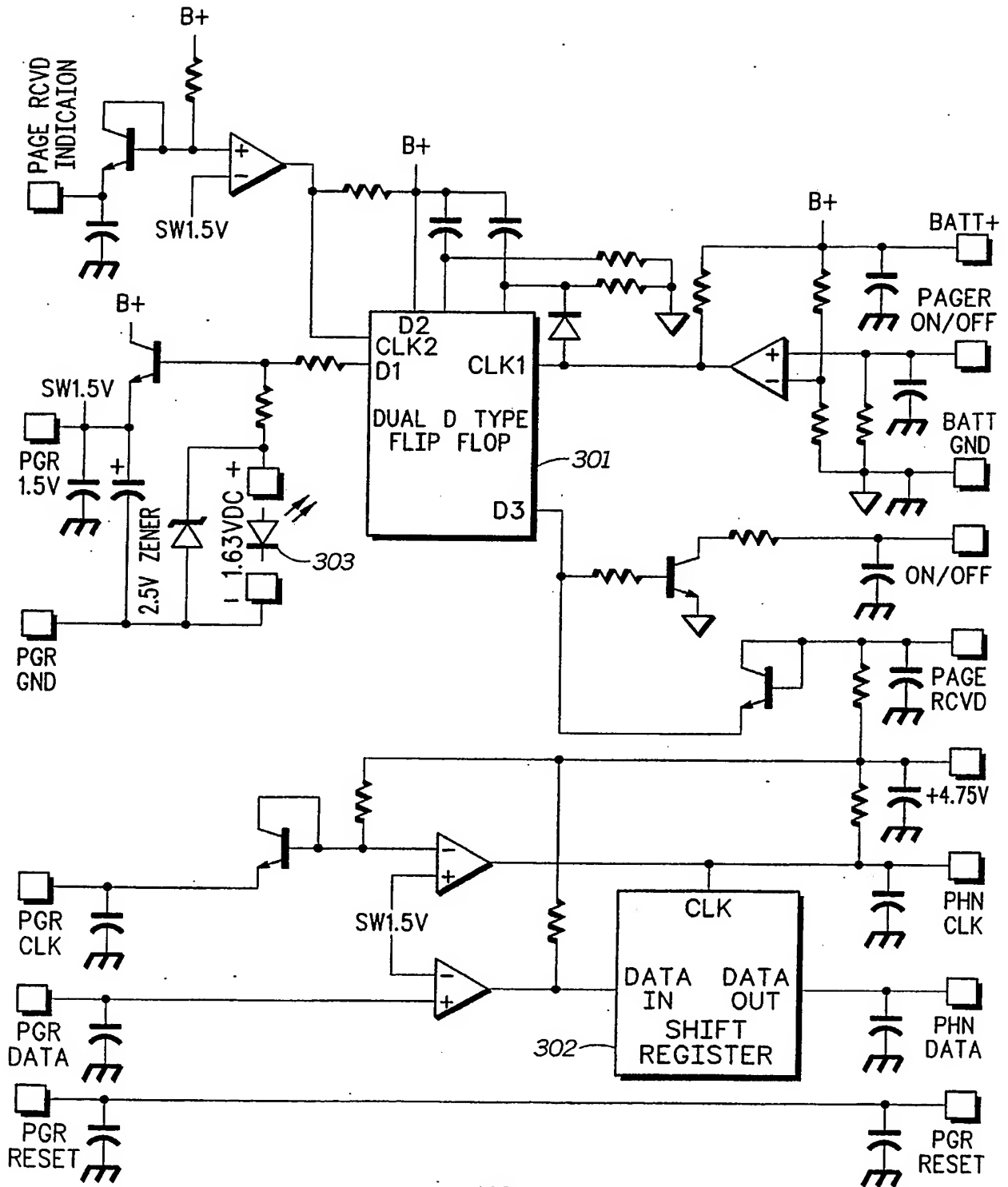
FIG.1

2/3

FIG.2

START

201 — PAGE RECEIVED ? → NO

YES

202 — PHONE ON ? → NO → 203 — POWER ON PHONE, SET POWER-ON FLAG, AND START WAIT TIMER

YES

IGNORE ON/OFF PULSE — 204

INCREMENT PAGE RECEIVED COUNTER AND DISPLAY MESSAGE — 205

206 — USER ACKNOWLEDGES ? → NO → 212 — POWER-ON FLAG SET ? → NO

212 → YES → 207 — CHECK WAIT TIMER → 208 — TIME EXPIRED ? → NO

YES

MOVE PAGES FROM PAGER TO PHONE MEMORY — 209

PROCESS USER INPUT — 210

208 → YES → 211 — POWER OFF PHONE

108

FIG.3

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